P 21: Helmholtz Graduate School 5

Time: Thursday 14:00–16:00 Location: b305

Invited Talk P 21.1 Thu 14:00 b305

Overview on turbulence in the shear- and scrape-off layer at W7-X — •Andreas Krämer-Flecken[1], Olaf Grulke[2], Xiang Han[1], Carsten Killer[2], Elisee Trier[3], Thomas Windisch[2], and Haoming Xiang[1] — [1]Institut für Energie- und Klimaforschung, Forschungszentrum Jülich, 52425 Jülich — [2]MPI für Plasmaphysik, Teilinstitut Greifswald, 17491 Greifswald — [3]MPI für Plasmaphysik, Teilinstitut Garching, 85748 Garching

For the investigation of turbulence activity in the shear- and scrape-off layer (SOL) of W7-X different diagnostics are used. Probe heads yield information on density- and temperature profiles and on turbulence rotation and radial electric field. Deeply in the SOL and the plasma edge correlation reflectometry measures turbulence spectra and the poloidal correlation length of dominant low k-turbulence.
The presentation intends to give an overview on turbulence phenomena at W7-X as there are e.g. quasi coherent modes which are observed close to the shear layer in the plasma edge. A decomposition of the coherence spectra allows to characterize them by a few turbulence components, only. Broad band turbulence extracted from those spectra is strongly suppressed in the vicinity of the shear layer supporting that low k-turbulence is torn apart in the shear region.
Furthermore, transient high frequency events in the range of 800 kHz - 1000 kHz are observed for certain magnetic configurations in the coherence spectra. They correlate with the observation of spikes in the diamagnetic energy and the plasma current.

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MHD simulations of ELM cycles in ASDEX Upgrade — •Andres Cathey Cevallos[1], Matthias Hoelzl[1], Michael Dunne[1], Guido Huijsmanns[2,3], and Sibylle Guenter[1] — [1]Max-Planck-Institut für Plasmaphysik, Garching, Germany — [2]CEA, IRFM, Saint-Paul-Lez-Durance, France — [3]Eindhoven University of Technology, Eindhoven, The Netherlands

Edge Localized Modes (ELMs) in tokamaks cause severe concern for future devices like ITER. Large ELMs lead to an expulsion of hot plasma from the edge of the confined region to the tokamak plasma facing components in 0.1–1 milliseconds repetitively every 10–100 milliseconds.

Simulations of single ELM crashes with the non-linear 3D magnetohydrodynamic (MHD) code JOREK [GTA Huysmans and O Czarny, NF 47 7 2007] have been validated qualitatively and quantitatively showing good agreement against experimentally observed ELM crashes. Such simulations start with unstable plasma equilibria. To become predictive the entire ELM cycle needs to be simulated. Here, we present simulations of ELM cycles in ASDEX Upgrade and thorough comparisons against experimental measurements. The difficulties related to simulating ELM cycles, how they were overcome with JOREK, and further steps necessary for a better and more comprehensive understanding of ELM dynamics will be discussed at length.

P 21.3 Thu 14:55 b305

Gyrokinetic investigation of the ASDEX Upgrade I-mode pedestal — •Karl Stimmel, Alejandro Banon Navarro, Tim Happel, Daniel Told, Tobias Goerler, Elisabeth Wolfrum, James Peter Martin Collar, Rainer Fischer, Phillip A. Schneider, Frank Jenko, and The ASDEX Upgrade Team — Max Planck Institute for Plasma Physics, Boltzmannstr. 2, 85748 Garching, Germany

Characterizing pedestal turbulence in the tokamak I-mode is a crucial step in understanding how particle and heat transport decouple during I-mode operation. This work models an ASDEX Upgrade I-mode discharge for the first time via linear and nonlinear gyrokinetic simulations with the GENE code. L-mode and I-mode regimes at two different pedestal locations are investigated. A microtearing mode which is not apparent in initial value linear L-mode simulations is found to dominate in I-mode simulations at both radial positions, and ion-scale instabilities are characterized for all four scenarios linearly. Computed nonlinear heat flux values approach experimental measurements with nominal input parameters in three of the four cases, and heat transport is found to be dominated by ion-scale electrostatic turbulence. Electrostatic potential oscillation frequencies, as well as potential-temperature and potential-density crossphases are compared linearly and nonlinearly, and agreement is found at wavenumber ranges corresponding with peaks in the simulated heat flux spectra at one radial position for L-mode and I-mode.

P 21.4 Thu 15:20 b305

Classification of tokamak plasma confinement states with convolutional recurrent neural networks — •Francisco Matos[1], Vlado Menkovski[2], Federico Felici[3], Alessandro Pau[3], Frank Jenko[1], The TCV Team[4], and The Eurofusion MST1 Team[5] — [1]Max Planck Institute for Plasma Physics, Garching, Germany — [2]Eindhoven University of Technology, Eindhoven, Netherlands — [3]Ecole Polytechnique Federale de Laussane, Swiss Plasma Center, Switzerland — [4]See author list of S. Coda et al 2019 Nucl. Fusion 59 112023 — [5]See author list of B. Labit et al., 2019 Nucl. Fusion 59 086020

During a tokamak discharge, the plasma can vary between different confinement regimes: Low (L), High (H) and, in some cases, a temporary (intermediate state), called Dithering (D). In addition, while the plasma is in H mode, Edge Localized Modes (ELMs) can occur. The automatic detection of changes between these states, and of ELMs, is important for tokamak operation. Motivated by this, and by recent developments in Deep Learning (DL), we developed and compared two methods for automatic detection of the occurrence of L-D-H transitions and ELMs, applied on data from the TCV tokamak. These methods consist in a Convolutional Neural Network (CNN) and a Convolutional Long Short Term Memory Neural Network (Conv-LSTM). We measured our results with regards to ELMs using ROC curves and Youden's score index, and regarding state detection using Cohen's Kappa Index.

P 21.5 Thu 15:45 b305

Dynamically assisted nuclear fusion — •Ralf Schützhold[1,2,3] and Friedemann Queisser[1,2,3] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstraße 400, 01328 Dresden, Germany — [2]Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany — [3]Fakultät für Physik, Universität Duisburg-Essen, Lotharstraße 1, Duisburg 47057, Germany

We consider deuterium-tritium fusion as a generic example for general fusion reactions. For initial kinetic energies in the keV regime, the reaction rate is exponentially suppressed due to the Coulomb barrier between the nuclei, which is overcome by tunneling. Here, we study whether the tunneling probability could be enhanced by an additional electromagnetic field, such as an x-ray free electron laser (XFEL). We find that the XFEL frequencies and field strengths required for this dynamical assistance mechanism should come within reach of present-day or near-future technology.

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